ATTACHMENT 12

LANDFILL 5 FACILITY DESCRIPTION

LANDFILL 5 FACILITY DESCRIPTION

1.0 GENERAL DESCRIPTION

The Utah Test and Training Range is a practice bombing and gunnery range for the United States Air Force. The UTTR is located in the northwest corner of Utah, just west of the Great Salt Lake. The Landfill 5 site is located at the extreme north end of Sink Valley in the eastern section of the UTTR, approximately 5 miles northeast of the Oasis Range Complex (Figure 1). Landfill 5 is located in T5N, R9W, Section 30, an area of unsurveyed land.

Landfill 5 is a hazardous waste disposal facility that was operated under interim status guidelines in compliance with Chapter 7 of the Utah Hazardous Waste Management Rules. It consists of six cells in which a variety of hazardous wastes were deposited between 1976 and 1983 (Figure 2). The landfill cells which are 90 feet wide by 150 feet long by 15 feet deep were dug in soil that is a light-gray alkaline silty-clay loam. The location of the landfill was chosen because of the low soil permeability, low annual precipitation, high evapotranspiration and remoteness of the site. Photographs of Landfill 5 and the Landfill 5 area entrance gate are shown in Figures 3a and 3b respectively.

The wide variety of wastes deposited in Landfill 5 were generated at HAFB. A summary of the most common items found in the landfill is given in Table 1. This table was generated from the operating record that was kept during the period of active use of the landfill. The table indicates a wide variety of hazardous wastes, including chlorinated and non-chlorinated solvents, heavy metals, PCBs, paints and paint strippers, IWTP sludge, cadmium-contaminated blast media, mercury, and asbestos, plus many others. The landfill was operated prior to land disposal restrictions (LDR) which now prohibits the disposal of liquid hazardous waste in landfills. As a result the unlined landfill contains over 2,000 55-gallon drums of liquid hazardous waste. Due to the highly caustic nature of the local alkaline soil the metal 55-gallon drums have likely rusted through. Many of the drums disposed of in the landfill were contaminated empties. This poses the possibility of collapse of the drums when they rust through and subsequent settling of the cap.

The use of Landfill 5 as a disposal site was discontinued in 1983. It was closed under conditions specified in the Post-Closure Permit and Closure Plan for Hazardous Waste Landfill/Storage Area, issued by the Executive Secretary of the Utah Solid and Hazardous Wastes Committee on July 15, 1988.

Since closure: 1) the low permeability RCRA cap, and security fences installed during closure have been inspected and maintained, and 2) the groundwater beneath the landfill has been monitored, in accordance with provisions of the Post-Closure Permit.

There is sufficient distance (at least 2 miles) from the actual target range to ensure that no inadvertent bombing will occur at the Landfill 5 site. The area is not used for livestock grazing nor is agriculture practiced here. The Landfill 5 area will not be used after closure or during the post-closure period. It will remain fenced for this entire period.

2.0 SITE HYDROGEOLOGY

2.1 Aquifer Description

Table 2 summarizes information that describes the uppermost aquifer at each well location at the site. The well locations are shown in Figure 4. The depth to the uppermost aquifer directly beneath the landfill is 415 to 417 feet, as evidenced by Wells H, I, and J1. The depth to water is slightly greater in Wells E, F, and G. This is a result of the rise in ground surface elevation. The absolute elevation of the uppermost aquifer is approximately the same over the area surrounding the site. No definable elevation contour pattern for the top of the aquifer was found.

The uppermost aquifer beneath Landfill 5 is not contained in a single stratigraphic interval or sedimentary unit. This is evidenced by the aquifer descriptions provided in Table 2. The valley fill materials under the landfill exhibit steeply dipping beds and lateral facies changes and the aquifer materials therefore, are significantly different in Wells H, I, and J1.

The aquifer material in Wells E, F, and G is somewhat similar in composition. Gamma logs from Wells E, F, and G indicate these wells are completed in similar geologic materials. In these wells, the aquifer is within bedded older valley fill deposits of uncemented and partially cemented gravel and sand deposits. The gravels are comprised primarily of black and gray microcrystalline limestones, probably derived from the Great Blue Limestone and the Humbug Formations The gravels also consist of dolomite, quartzite and calcite. Colors of the gravels range from black and gray to white, tan, orange, and red.

Groundwater in the uppermost water bearing strata is under artesian pressures in all wells at the site. Water level rises in Wells E, F, G, H, I, and J are between 20 and 40 feet above the top of the aquifer. In addition, Wells 1, 2, A, B, and D are also reported to have penetrated artesian conditions at the time they were drilled.

No single distinct confining unit can be correlated between wells. Two types of confining units may exist within the valley fill sediments. Both types consist of calcium carbonate cement. The first type of cementation occurred at the time of deposition. These confining units are suspected to be very localized and discontinuous and consist of inter-bedded carbonate muds and carbonate cemented sand and gravels. The second type of cementation is aerially extensive and cuts across sedimentary units. These confining units are related to paleo-water levels in the valley fill sediments. Both forms of cementation were probably caused by mixing of waters of differing dissolved calcium concentrations or by temperature and pressures changes that caused the precipitation of calcium carbonate. The carbonate cementation that immediately overlies the first water bearing zone at the site is probably a combination of the two types described. The confining unit at the site is known to cut across geologic units regardless of the aquifer material or the overlying geologic materials.

The aquifer thickness varies between each well location. Generally, the uppermost aquifer is not one thick consistent geologic material, but instead is comprised of inter-bedded sand and gravel deposits. The water yielding strata range from 2 to 5 feet in thickness. Each well is completed adjacent to several zones which produce water. The total thickness of water bearing strata was estimated using geophysical logs and varies from 19 feet in Well J to 5 feet in Well G.

2.2 Aquifer Properties

Aquifer pump tests were conducted in Wells E, F, G, H, I, and J to determine the saturated hydraulic properties of the uppermost aquifer. Two analytical methods were used to interpret the aquifer pump test data. The standard Theis non-equilibrium solution for aquifer recovery data was the primary method used to estimate transmissivity for each well. The Cooper and Jacob semi-log method was also used to interpret the aquifer drawdown data for Wells I and J. The slug recovery test in Well E was analyzed using the method described by McWhorter and Sunada (1977). Table 3 summarizes the results of aquifer pump tests. The actual pump test data can be found in the post-closure permit application.

Transmissivity estimates range from 12 to 150 ft^2/day for the uppermost aquifer at the site. These values are relatively low and are several orders of magnitude less than transmissivity estimates from wells farther south in Sink Valley. Transmissivity values between 10 and 100 ft^2/day are considered fair for domestic water supply purposes.

Results of the Jacob semi-log analysis of Well I show that the drawdown data follow a straight line solution until time is greater than 10 minutes. After 10 minutes the drawdown is less than that predicted using the Theis solution. This deviation can be caused by leakage from underlying aquifers. Results from Well J also show a flattening out of drawdown at times greater than 15 minutes into the test. This test also indicates recharge or leakage from adjacent aquifers.

2.3 Hydraulic Conductivity

Saturated hydraulic conductivity (K_s) values can be estimated from transmissivity data using the relationship

$$K_s = T / b$$

where
T = aquifer transmissivity (ft^2/day)
b = saturated aquifer thickness (ft)

Aquifer thickness was estimated from geophysical logs for the wells, and is summarized on Table 2.

Storativity Estimate Ranges:

S = about 10^{-3} to 10^{-4}
S = pgbe (assuming compressibility of water is negligible)

where:
pg = Gravity x density of water (62.4 lbs/ft^3)
b = Aquifer thickness (Table 2)
e = Aquifer compressibility

Ranges:
Loose sand 2.5 - 5.0 x 10^{-6} ft^2/lb
Dense sand 6.2 x 10^{-7} - 1.0 x 10^{-6} ft^2/lb
(Freeze and Cherry, 1979, p. 55)

Saturated hydraulic conductivities range from 3 to 15 ft/day for aquifer materials at the site (see Table 3). These values are representative of silty sands to fine sand and gravel deposits (Freeze and Cherry, 1979). The lower hydraulic conductivities were found in Wells E, F, G, and J. Wells H and I are characterized by hydraulic conductivities about 2 to 3 times higher than other wells at the site.

2.4 Storage Coefficient

Single well aquifer pump and recovery tests do not allow for a reliable calculation of the aquifer storage coefficient. The aquifer storage coefficient was, therefore, estimated using the relationship:

$$S = p\,g\,b\,e$$

where:

p	=	density of water (62.4 lbs/ft
b	=	aquifer thickness (Table 2)
g	=	gravitational constant
e	=	aquifer compressibility

Aquifer compressibilities for a range of geologic materials are listed in Freeze and Cherry (1979). Representative values for fine and dense sands were used to estimate aquifer storage coefficient.

Table 3 shows the range of aquifer storage coefficient to be 10^{-3} to 10^{-4}. These values are within the range reported by Todd (1980) and Freeze and Cherry (1979) for confined aquifer systems and are, therefore, considered representative.

The aquifer storage coefficient has merit in the characterization of groundwater systems for water supply development; however, it is not needed in determining groundwater flow direction and velocity.

2.5 Groundwater Flow Direction and Rate

2.5.1 Water Level and Hydraulic Gradient Data

Water level data for the site, collected in December 2000 and April 2001, are shown in Table 4. The potentiometic head data indicate a very flat horizontal gradient, with a maximum gradient of 0.000095 feet/foot from monitoring well J1 to G. The flatness of the groundwater gradient indicates that the direction of flow is very difficult to determine and may be within the margin of error of the groundwater elevation measurements.

Vertical hydraulic head differences may exist with the water bearing strata in the vicinity of the site. Wells at the site are known to be completed in varying geologic materials. Some wells may penetrate deeper, more confined water-bearing strata and thus exhibit higher static water levels. Documentation that is available indicates that some wells installed prior to 1986 do penetrate deeper into water-bearing strata and are screened adjacent to longer sections of water-bearing strata. These wells have static water levels in the 4,219 - 4,220 foot range. Wells installed in 1986 or later by CH2M HILL do not penetrate significantly different depths into the water-bearing strata. These wells exhibit water levels that vary 4 to 5 feet between well locations. Therefore, water levels in the first 40 feet of water bearing materials may vary locally across the site.

Due to the complex bedding of strata in the valley fill, monitoring wells are completed in geologic materials of varying hydraulic conductivity Wells E, F, G, and J are screened adjacent to materials with saturated hydraulic conductivities of less than 7 ft/day. Wells E, G, and J have static water levels that are 1 to 5 feet lower than other wells surrounding the landfill, particularly Wells H and I. Wells H and I are screened adjacent to materials having hydraulic conductivities of about 15 ft/day. Well F, although screened adjacent to lower conductivity material, has water levels similar to Wells H and I. Geologic materials with higher hydraulic conductivities may act as preferential pathways for water flow and may exhibit higher static water levels.

Northern Sink Valley is bounded on the north, east, and west by bedrock mountains and knolls. The valley width decreases and the underlying bedrock surface becomes shallower towards the northern extent of the valley. Deep circulation of groundwater through faults in the area has not been reported and is not suspected from the existing data. The limestone bedrock in the area is assumed to have a much lower permeability than the valley fill sediments. Consequently, the upper end of Sink Valley is potentially closed off to northward groundwater flow through the colluvial sediments into the bedrock.

The hydraulic gradient in the vicinity of the landfill is not clearly defined. The implied groundwater flow path, based on the physiographic setting of the site, is down valley from north to south in the vicinity of the site.

2.5.2 Groundwater Velocity

Groundwater flow velocity can be estimated from the relationship.

$$V = \frac{K_s \; i}{n_e}$$

where:

V	=	groundwater velocity (ft/day)
K_s	=	saturated hydraulic conductivity (ft/day)
i	=	hydraulic gradient (ft/ft)
n_e	=	effective porosity

Effective porosity values for sand and gravel mixes range from 0.10 to 0.35. Hydraulic conductivity values have been previously determined to range from 3 to 15 ft/day for geologic materials at the site. The hydraulic gradient, however, has not been determined in the vicinity of the site and the groundwater velocity cannot be estimated.

TABLE 1
Partial* Summary of Waste Disposed of in Landfill 5

Number of Containers	Size of Container	Material
965	55-gal	Beryllium contaminated material from of aircraft breaks
10	box	Mercury wastes
27	55-gal	Trichloroethylene
278	55-gal	Trichloroethane
171	55-gal	Oils and greases
6	55-gal	Methanol
1	55-gal	Toluene
11	55-gal	Epoxies
12	55-gal	Hydraulic fluid
15	55-gal	Methylene chloride
16	55-gal	Asbestos
27	55-gal	Freon
21	55-gal	Chromate paint residue
79	55-gal	Unknown paint residue
477	55-gal	Paint remover / Stripper waste
32	55-gal	Alcohol wastes
376	55-gal	Organic solvents
7	55-gal	PCB contaminated transformers
66		
10	55-gal	Methyl ethyl ketone waste
38	55-gal	Lacquer thinner
21	55-gal	Penetrant (dirty)
144	55-gal	Styrofoam contaminated barrels (mostly empty)
27	55-gal	waste sealer
7232		
998		
1	55-gal	Tirchloro-trifluoromethane
291	55-gal	Si Sulfa Sol waste
12	55-gal	Alkaline paint stripper
95	55-gal	Slop paint
12	55-gal	Cleaner waste
4	55-gal	Dichloromethane (contaminated)
12	55-gal	Chromate wastes
4	55-gal	Etchant
1	------	Asbestos insulated boiler
369	$yard^3$	JP-4 impregnated foam

*This summary is not a complete list of all items in the landfill; it should be fairly complete for the most common items found in the landfill. It was compiled from the operating record.

TABLE 2
Summary of Aquifer Characteristics for Landfill 5

Well No.	Depth to Top of Aquifer (ft)	Top of Aquifer Elevation (ft above msl)	Aquifer Thickness (ft)	Aquifer Description
E	438	4174	8	Sand, gravel with clay, sand is fine to coarse, gravels are <0.4" diameter, consist of ls, ss, and calcite. Drilling hard.
F	482	4187	15	Gravel with sand, gravels <0.5-inch diameter, black and gray ls, some tan and orangish ss, sand is fine grained and pale brown. Drilling is hard with soft spots indicating interbedding.
G	442	4186	5	Coarse sand and gravel, no fine sand or silt, gravel is angular, <0.5 inch diameter and consists of gray and black limestone. Drilling very hard.
H	420	4186	8	Sand and cemented sands, sand is fine to coarse with no gravels or silt, cemented sand is fine to very fine grained and moderately cemented. Drilling very soft and smooth.
I	427	4175	10	Sand and gravel, sand is fine to coarse grained, contains some silt, gravel is fine to medium, black and brown limestone.
J	417	4186	19	Sand with minor silt and gravel, sand is fine to medium grained, single grained, multicolored brown and gray. Silt is light brown. Gravels are limestone. Drilling moderately soft.

TABLE 3
Summary of Principal Aquifer Data at the UTTR Landfill 5

	Transmissivity (ft^2/day)			
Well No.	**Slug Recovery Data**	**Constant Pumping Recovery Data**	**Jacob Semi-Log Pumping Well Data**	**Estimated Saturated Hydraulic Conductivity**
E	12	24		3
F		104		7
G		35		7
H		110		14
I		150	78	15
J		94	33	5

TABLE 4
Summary of Water Level Data for Landfill 5

Monitoring Well	Measuring Point Elevation (ft MSL)	Inclination Correction (ft MSL)	Groundwater Depth 12/18/00 (ft bmp)	Groundwater Elevation[1] 12/18/00 (ft MSL)	Groundwater Depth 4/16/01 (ft bmp)	Groundwater Elevation[1] 4/16/01 (ft MSL)
MW-E	4615.35	2.32	397.04	4220.63	396.75	4220.92
MW-F	4673.03	2.16	454.58	4220.61	454.17	4221.02
MW-G	4631.52	4.79	415.85	4220.46	415.60	4220.71
MW-H	4608.98	.89	389.66	4220.21	389.25	4220.62
MW-I	4604.03	2.01	385.63	4220.41	385.29	4220.75
MW-J1	4606.55	.45	386.73	4220.27	386.32	4220.68
TTU-1	4859.02	1.32	649.44	4210.90	649.01	4211.33
TTU-2	4720.76	.38	505.73	4215.41	505.40	4215.74

[1]Groundwater Elevation = Measuring Point Elevation – (Groundwater Depth – Inclination Correction)

Ft – feet

Bmp – below measuring point

MSL – above Mean Sea Level